ENTROPY IN HOT NUCLEI

S. Siem[a], E. Algin[b], U. Agvaanluvsan[c], M. Guttormsen[a], R. Chankova[a], F. Ingebretsen[a], G. Mitchell[d], U. A L.A. Bernstein[c], J. Rekstad[a], A. Schiller[e], C. Sunde[a], S. W. Ødegård[a], A. Voinov[f]

[a)] *Department of Physics, University of Oslo, N-0316 Oslo*

[b)] *Department of Physics, Osmangazi University, Meselik, Eskisehir, 26480 Turkey*

[c)] *Lawrence Livermore National Laboratory, Livermore, California 94551, USA*

[d)] *North Carolina State University, Raleigh, North Carolina 27695, USA*

[e)] *NSCL/MSU, 164 South Shaw Lane, East Lancing, MI 48824, USA*

[f)] *Frank Laboratory of Neutron Physics, Joint Institute of Nuclear Research, 141980 Dubna, Moscow reg., Russia*

Recently, [1,2], the Oslo group has developed a technique to measure with high precission the level density from the ground state up to the neutron binding energy. The method provides simultaneously the level density and gamma-ray strength function in one and the same experiment. After establishing the level density as a function of excitation energy, $\rho(E)$, the entropy is known by $S(E) = k_B \ln \rho(E)$ and we can explore various thermodynamical parameters of the nucleus. The caloric curve $T(E)$, derived within the framework of the micro-canonical ensemble, shows structures, which we associate with the break up of nucleon pairs. The nuclear heat capacity is deduced within the framework of the canonical ensemble and exhibits an S-shape as function of temperature, indicating a pairing transition.

Important applications of nuclear level densities are the determination of nuclear cross sections from Hauser-Feshbach type calculations. These cross sections are used as input parameters in large network calculations of stellar evolution, and in the simulation of accelerator-driven transmutation of nuclear waste. Unfortunately, the predictions of such calculations suffer from the lack of experimentally determined level densities. To day our knowledge is mainly based on the counting of discrete levels in the vicinity of the ground state and neutron resonance spacings at 6-8 MeV of excitation energy.

I will begin by presenting experimental data on the close to spherical ^{148}Sm and ^{149}Sm nuclei and compared with the well deformed ^{161,162}Dy, ^{166,167}Er and ^{171,172}Yb nuclei[3]. Then preliminary result for ^{143,144,146,147}Sm will be shown and the deformation dependency of the pygmy resonance in the radiative strength function of samarium isotopes (as one approaches and crosses the N=82 closed shell) will be discussed.

[1] A. Schiller et al., NIM A**447** (2000) 494.
[2] E. Melby et al., Phys. Rev. Lett. **83** (1999) 3150.
[3] S. Siem et al., Phys. Rev. C**65** (2002) 021306. and references therein.